COTTON IRRIGATION

in the Southwest

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CONTENTS

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COTTON IRRIGATION IN THE SOUTHWEST

by

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INTRODUCTION

The acreage of irrigated cotton in the United States has increased rapidly during recent years, and it is now irrigated in many areas where it was unthought of 30 years ago. In 1953 the United States irrigated a total of 3,503,000 acres of cotton. Texas alone irrigated about 939,500 acres of cotton in 1948, 1,200,000 acres in 1953, and 1,939,998 acres in 1955.

Cotton is adapted to a wide range of soil conditions and produces well on both fine- and coarse-textured soils. It is relatively tolerant to saline soil conditions that commonly occur on irrigated lands in the Southwest.

Cotton is generally considered a warm climate crop and needs at least 190 rather warm, frost-free days to produce a high yield. However, good production has been attained under a variety of conditions ranging in elevation from below sea level in the Imperial Valley of California to 4,000 feet in Arizona, and in climate from the arid regions of the Southwest to the subhumid areas of the Southeast.

METHODS OF IRRIGATING COTTON IN THE SOUTHWEST

The cotton farmer can choose any one of several methods of applying water to his land. The method chosen should be so adapted that the desired quantity of water can be uniformly distributed over the field with a minimum of labor and without appreciable soil or water losses.

In choosing a method of applying water, many factors must be considered. The most important are:

1. Size of stream. Small irrigation streams cannot be efficiently used on wide borders or highly permeable soils.
2. Total amount of water that must be supplied by irrigation. In areas where plants receive a major part of their water from irrigation, higher installation costs are more justified than in areas where a major portion of the water is supplied by rainfall.
3. Salinity. Larger volumes of water must be applied to maintain favorable salt balance.
4. Topography. The land surface determines largely the relative costs of preparing the land for irrigation by different methods.
5. Soil absorbability. The intake rate (or the rate the water enters the soil) determines the size stream in each furrow and the length of the run. If the intake of water into the soil is slow, a small stream should be placed in each furrow and the length of run may be relatively long. On the other hand, if the intake rate is high, a large size stream should be used and the length of run should not be as long as where the intake rate is slow.
6. Nature of the soil profile. It is important to have sufficient soil depth to permit land leveling and subsequent storage of water. Coarse-textured soils or restrictive layers within the profile can adversely affect water storage, root development, and management of irrigation systems.
7. Amount and intensity of rainfall. If much rain or rains of high intensity are expected, then provisions for handling surface drainage must be provided.
8. Kind of earth-moving machinery and farm equipment available.
9. Land ownership and capital available for land preparation. A less permanent type irrigation system requiring less land preparation may be justified on leased land.

Assistance in selecting the most suitable irrigation system and in designing the system for specific situations can be obtained from technicians of the local Soil Conservation Service or State Extension Service. There are three principal methods of irrigating cotton in the Southwest, by furrows; borders, or basins; and sprinklers. These are discussed below.

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Furrow Method

The furrow method is most commonly used for irrigating cotton. Furrows may run directly down or across the slope, or may be level. Water can be introduced at either end of level furrows.

Leaching of excess salts from the soil profile is most satisfactorily accomplished by means of level furrows. In areas of high intensity rainfall, level furrows conserve moisture ordinarily lost by runoff from graded irrigated systems. Figure 1 illustrates such a condition following a 6-inch storm. However, where ponded surface water endangers crop survival, some emergency drainage facilities must be provided to remove excess water.

Figure 1. Water retained on level furrow irrigated field following 6-inch rainfall.

In many areas furrow irrigation on moderate slopes may be used if the furrow streams are small. (See fig. 2.) However, where large furrow streams are used or high intensity rainfall occurs, erosion will result.

On sloping lands, furrow grade should be limited to about 0.3 percent, and the length of run shortened to control erosion and provide adequate drainage. The contour furrow method may be desirable on steeper slopes. This method reduces furrow slopes within the field and permits increased penetration of water into the soil.

Figure 3 illustrates erosion caused by a 6-inch rainfall of high intensity. Adequate irrigation design for water control could have prevented this damage. Similar soil losses are often caused by using erosive irrigation streams or by a lack of facilities to carry runoff water.

Figure 2. Furrow irrigation of cotton near Safford, Ariz. This method of irrigation is satisfactory on moderate slopes in areas of low intensity rainfall. Water is run in direction of steepest slope and a nonerosive size stream put in each furrow.

Level-Border or Basin Method

Level irrigation and border irrigation are not synonymous. Border irrigation is running water between low dikes and can be on steep ground or relatively flat ground.

Basin irrigation is closed at the two ends of the border which are at the same elevation. The water runs into the basin and remains until it soaks into the ground. The basin may be less than an acre up to 10 acres or larger. At Yuma, Arizona, for example, 10-acre basins are quite common. The terms level border or basin are synonymous.

Level border or basin systems provide highly efficient methods of water application. As with level furrows, this method is especially adapted where intake rates are not excessive or where leaching of salt is required. Each border, or basin, can be filled with the proper amount of water in a relatively short time providing stream sizes from 2 to 4 cubic feet per second are available. All applied water is retained within the basin, thus avoiding wasteful runoff that occurs from graded systems. In areas of high intensity rainfall, provision must be made for draining excess water from the basins, with level furrows for example, to avoid damage that might result

Figure 3. Damage from erosion on a relatively steep slope following 6-inch rainfall.

from submergence of the plants or washing out of dikes. This method of applying water is gaining in popularity throughout Arizona and Texas. (See fig. 4.)

Sprinkler Method

In most areas where cotton is grown, sprinkler irrigation can be used satisfactorily, and under certain conditions this method of irrigation may be the only suitable one. The method is especially adapted to steep slopes, to shallow soils that cannot be leveled, to coarse-textured soils that have high intake rates, or to areas requiring a small amount of supplemental water. Light irrigations can be applied and used efficiently on many soils. Sprinkler irrigation is less satisfactory than surface irrigation in windy areas. Here poor water distribution results from wind drift. In certain areas of California and Texas, sprinkler irrigation of cotton is becoming very popular.

IMPORTANCE OF GOOD ROOTING IN IRRIGATION OF COTTON

Cotton roots are capable of extracting moisture from depths of 6 feet or greater under favorable environmental conditions. Generally speaking, high production is associated with deep-rooted plants. Hundreds of field observations made in Arizona, California, New Mexico, and Texas support this statement. More frequent irrigations required for shallow-rooted plants provide greater possibilities of excessive percolation losses including both water and plant nutrients, increase the danger of developing plant stress during critical growth periods, and generally result in lower yields and higher production costs.

Cotton roots will not penetrate effectively into dry soil. Hence, the depth of the root system is limited by the depth of moist soil. Recommended preplanting irrigations that moisten the soil to depths of 6 feet or more provide one of the necessary requisites for a deep-rooted crop.

Figure 4. Level-border or basin irrigation in Texas, typical of that found in Arizona and Texas. This is a highly efficient method of water application and is well adapted where intake rates are not excessive, where leaching of salts is required, or where both of these conditions are encountered.

Shallow root systems can be the result of other growth-limiting factors including: (1) Limited oxygen supply, (2) too low or too high soil temperatures, (3) dense or fine-textured soil layers, (4) excessive salt concentration, and (5) plant root disease or parasites.

Frequent and excessive irrigations applied to soils with slowly permeable layers near the surface may exclude air for critical lengths of time and thus retard or completely stop root growth. These restrictive layers often are caused by excessive tillage operations in preparation of seedbed, or they may be the result of natural soil-forming processes.

Irrigations applied when soil temperatures are high stimulate cotton growth in the early stages of development. Conversely, irrigating the crop when soil temperatures are low usually retards growth. Whether the reduction of high soil temperatures or the replenishment of moisture at the root surfaces of small plants, or combinations of both, are the reasons why plant growth is stimulated, the fact remains that irrigating cotton under these conditions appears to be essential for high production.

Dense subsurface layers, whether naturally occurring or the result of compaction by tillage, sometimes check root penetration. Thus, in addition to the effects of unfavorable aeration in such layers, roots may be mechanically impeded from exploring deeper soil layers.

Salt accumulations in the soil may be sufficiently high to prevent root development. Such accumulations frequently occur above or in soil layers that impede water movement when irrigation water with a high sodim percentage is used.

Figure 5 illustrates a common condition of salt accumulation in irrigated areas of the Southwest. Note the good cotton growth at the upper and lower ends of rows in contrast to the poor stand or absence of growth midway down the rows. The good plant growth is associated with better water penetration and a more favorable salt balance in the soil profile. Water penetration on the relatively bare area is slow because of excessive salt accumulation. Such a soil

Figure 5. Salt accumulation causes bare spots in irrigated cotton fields of the Southwest. This condition may be alleviated by proper water management.

condition prevents or retards seed germination and plant growth. Above and below the nonproductive area, irrigation water has run longer or has ponded sufficiently to permit more leaching; thus the salt accumulation has been kept within tolerable limits for plant growth.

A soil-borne disease, such as cotton root-knot, or nematode, frequently prevents deep root penetration. Nematode is a parasite that forms on the roots of many plants. Cotton is only one of the plants which is affected. It is a very common soil-borne plant disease.

Good soil management practices are important in maintaining the soil in a condition conducive to maximum root development. Excessive tillage should be avoided to minimize tillage-pan development. Dense layers sometimes can be successfully disrupted by deep plowing or chiseling. Legumes, such as alfalfa and sweet clover, have been used successfully in some areas to increase the depth of cotton root penetration. Such management practices not only promote deep root penetration but also improve water penetration and air movement.

Figure 6 shows how root-retarding layer, resulting from poor cultural practices can cause undesirable root development in cotton plants. The two cotton plants were seeded in the same field on the same date and were given the same number of irrigations. The plant on the left shows the effect of a root-retarding layer. The plant on the right was grown under more favorable conditions. Notice the difference in the size of the stem and in root development.

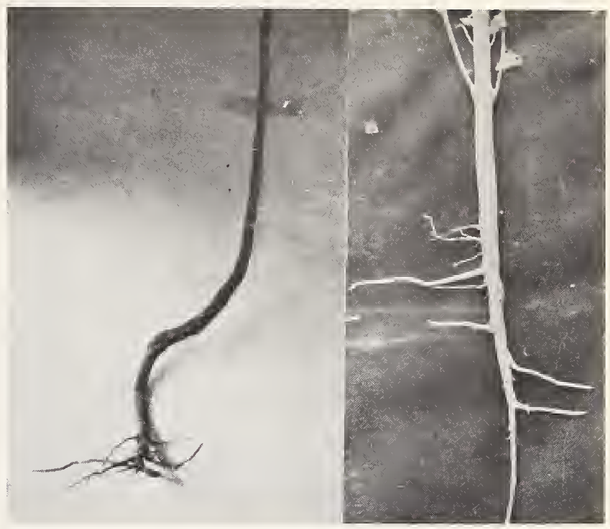


Figure 6. The cotton root development on the left shows the effect of a tillage hardpan, that on the right shows normal growth.

The average total water percentage extracted by cotton from different portions of the root zone on a deep, fertile, well-drained soil near Phoenix, Ariz., is shown in figure 7. Note that the percent of water used by cotton plants from the lower depths

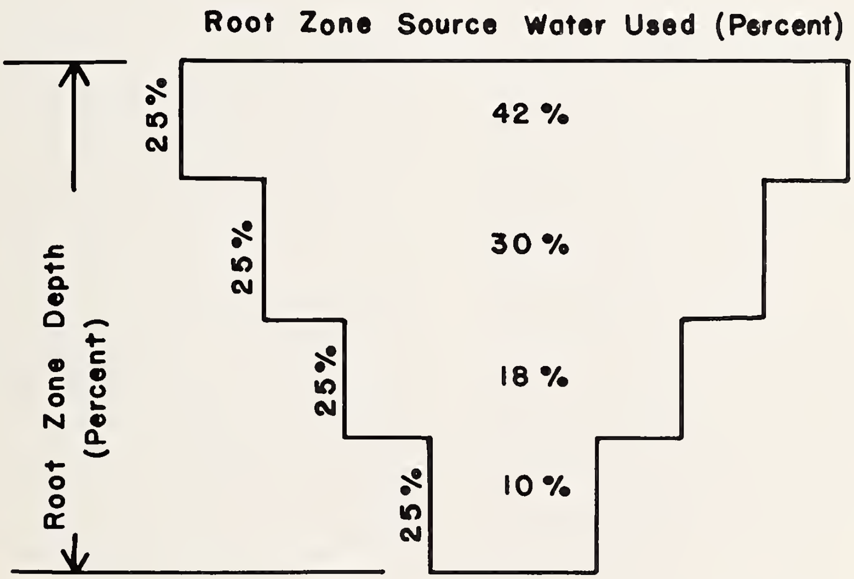


Figure 7. Typical pattern of average water use by cotton plants on deep uniform soil near Phoenix, Ariz.

is relatively small. The importance of this deep moisture, however, is significant in cotton production, since it provides a reserve source during high moisture use periods and for maturing the late season bolls.

TILLAGE AND SEEDBED PREPARATION

One of the major requirements for obtaining a high yield of cotton is a well prepared seedbed that allows adequate movement of air and water through the soil. On many soils in the Southwest, leaching residual salts from the soil and providing stored water at the lower depths for late-season use is possible only at the time of the preplanting irrigation. Often the rate at which a soil can absorb water during the preplanting irrigation is reduced by excessive seedbed preparation.

"Rough or minimum" tillage practices on relatively nonstable soils that tend to seal when wet can increase intake rates. In Arizona "rough tillage" consists of plowing below a manmade tillage pan, usually at a depth of 14 inches or less, when the soil is relatively dry. Then, without further seedbed preparation, sufficient water is applied ("preplanting irrigation") between border dikes or in deep furrows to wet the soil to a depth of about 6 feet. (See fig. 8.) The final seedbed is prepared with "minimum tillage" when moisture conditions permit, an operation that may consist of only a light harrowing or dragging.

Research and field experience have shown that better soil conditions and in many instances, increased yields result when this system of preparing land for pre-irrigation and planting is used. Average data covering a 4-year period at Mesa, Ariz., on long staple cotton showed an increase in yield of lint cotton from 200 to 505 pounds per acre when the volume weights of a 3-inch compacted layer within the top foot was reduced from 1.65 to 1.40. At the same time, "excess tillage" costing as much as $15 an acre was eliminated.

A modification of the "rough" tillage method utilizes a "raised bed" arrangement. The preplanting irrigation is applied after the beds are shaped. Planting in the moist bed is frequently accomplished by simultaneously removing the top dry layer of soil.

Cotton may be planted on raised beds, in furrows, or on the flat. Bed planting is popular in areas where specialized machinery is available. Furrow planting is utilized where germination is a problem because of lack of moisture or where saline water is used. Planting on the flat is perhaps the simplest method and requires less specialized machinery.

Figure 8. Preplanting irrigation at Mesa, Ariz., on rough plowed land permits more rapid penetration of water, replenishment of water in root zone reservoir, leaching of excess soluble salts, and storage of water in lower depths for late-season use.

CONSUMPTIVE USE OF WATER BY COTTON

Irrigation water is used to supplement water supplies to the plant by precipitation or ground water. Cotton-producing areas vary somewhat as to the relative proportion of the total water needs of plants that is supplied by each of these three sources. The farmer has no control over precipitation and little control over the water supplied from underground sources, but should have complete control over the irrigation water applied.

In most cotton-producing areas of the Southwest, irrigation supplies a major portion of the water used by plants. Where

application of irrigation water is delayed in anticipation of rainfall, serious yield reductions can occur. However, in some areas, one or two applications of irrigation water adequately supplement other water sources.

Considerable work has been done on the water use of both the American Egyptian and the Acala varieties of upland cotton at the University of Arizona Farm, Mesa. Table 1 shows the inches of water used by cotton at Mesa during a 7-month period, April through October, in specified years. In all years, soil moisture was adequate to permit continous growth throughout the season.

Table 1. Monthly and seasonal water use by cotton from April through October for 6 years, Mesa, Ariz.[1]

Month	Year						
	1935	1936	1951	1952	1954[2]	1955[3]	Average
	Inches						
April	1.1	1.1	1.0	1.6	1.3	0.2	1.0
May	1.6	1.5	2.2	3.1	2.2	1.3	2.0
June	3.4	3.6	4.2	4.8	6.1	3.7	4.3
July	7.1	6.4	8.0	8.6	10.9	6.3	7.9
Aug.	7.7	8.1	8.8	8.7	10.5	8.5	8.7
Sept.	6.7	5.7	6.6	5.3	8.0	7.1	6.6
Oct.	5.5	2.2	2.4	3.4	5.6	3.2	3.7
Total	33.1	28.6	33.2	35.5	44.6	30.3	34.2

[1] Water use was determined for 0- to 6-foot zone. Some extraction may have occurred from greater depths.
[2] Very favorable year for cotton. Plants over 5 feet tall; yields over 3-1/2 bales of lint per acre.
[3] Poor cotton year having an abnormally short and cool growing season.

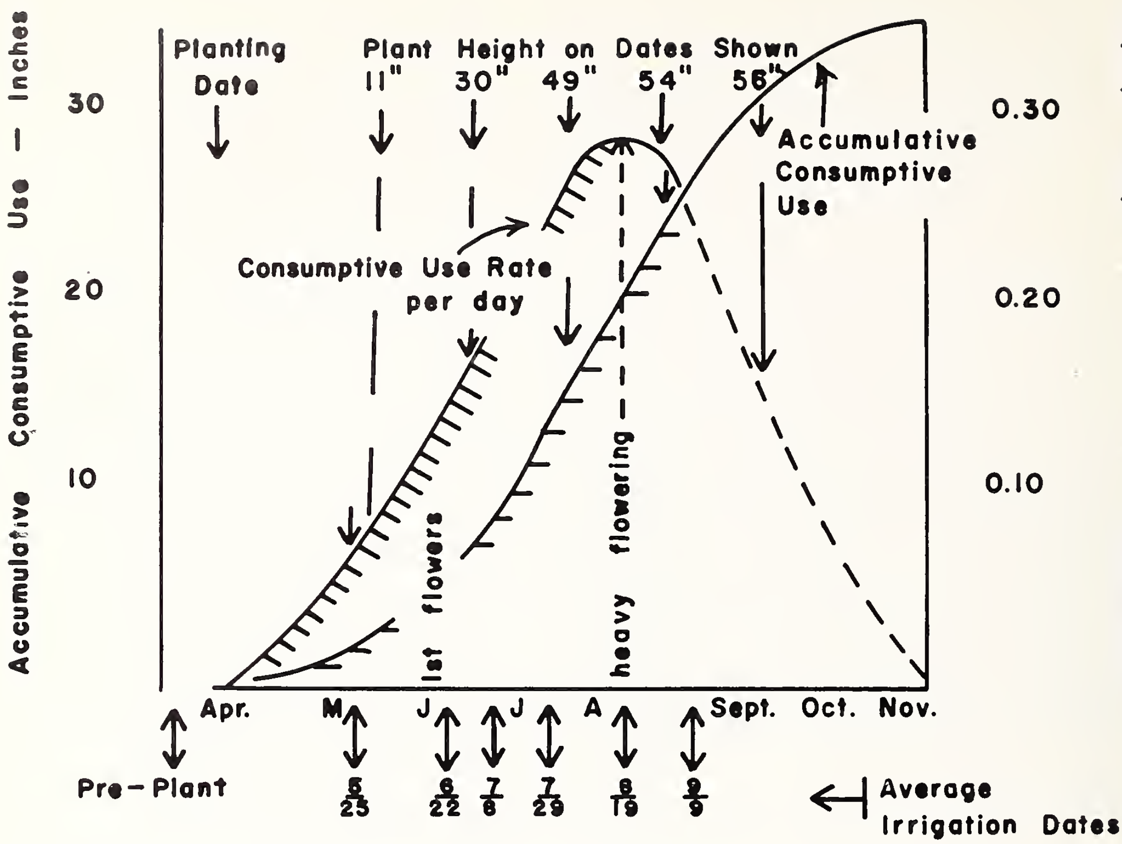
Accumulative and 15-day-interval consumptive use values, daily consumptive use rates in inches per day, and plant height for short staple cotton grown in the Salt River Valley, Ariz., are shown in figure 9. Note that the approximate maximum plant height and the heavy flowering period correspond to the period of maximum daily use rate. This period also occurs during the hottest part of the growing season. Irrigations are then more frequent and, for the 6 years, average about 5 inches each at this time. Average daily peak use rates amount to 0.30 inch over 15-day intervals, and during shorter periods of time have been as high as 0.40 inch per day.

From results of experimental studies conducted throughout the Western United States, an empirical formula was developed by Blaney and Criddle[3] relating temperature, length of growing season, and monthly percent of annual daytime hours to seasonal consumptive use of water by various crops. By using this relationship, seasonal consumptive use and irrigation water requirements for cotton can be <u>estimated</u> for any area where the necessary climatological data are available. This method gives an estimate of the seasonal use, but not reliable information on monthly or peak-period use.

The total water that can be available for production depends upon the amount of residual or stored soil moisture, effective growing-season rainfall, and the efficiency by which irrigation water can be supplied to the root zone. It is very difficult to estimate the effective rainfall because of its varying intensities and its distribution.

Table 2 presents consumptive use estimates (using a "K" value of 0.72)[3], rainfall data and irrigation water requirements for eight locations. The constant "K" has been determined experimentally a number of times in studies conducted at Phoenix, Arizona. Consumptive use figures

[3] Blaney, Harry F., and Criddle, Wayne D. Determining Water Requirements in Irrigated Areas from Climatological and Irrigation Data. Soil Cons. Serv. Tech. Paper 96, 44 pp. (1950).



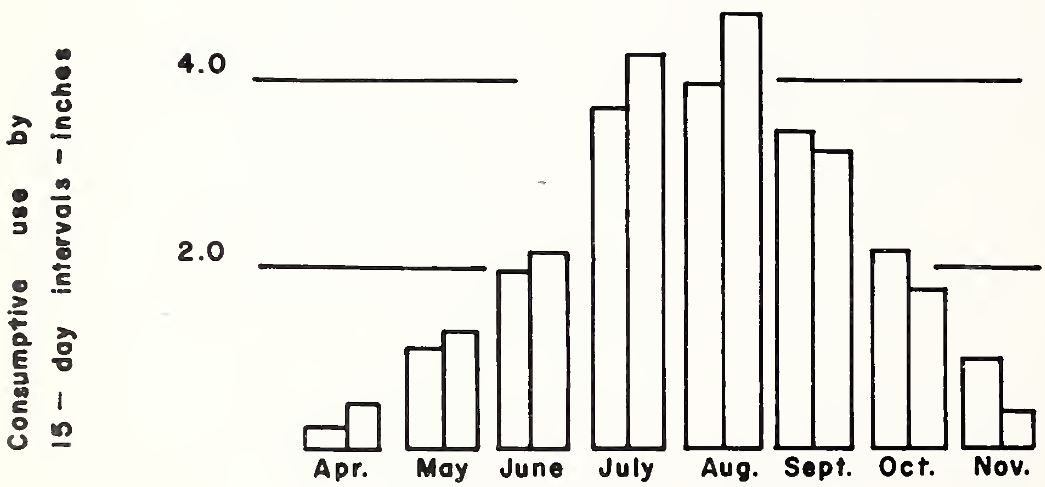


Figure 9. Accumulative consumptive use and daily consumptive use rates (top) and consumptive use by 15-day intervals (bottom) for short staple cotton grown in the Salt River Valley, Ariz.

Table 2. Estimated consumptive use and irrigation water requirements of cotton and rainfall data for 8 locations.

Place	Consumptive use[1]	Effective rainfall	Total irrigation water requirements[2]
	Inches	Inches	Inches
Memphis, Tenn.	31.7	27.6[3]	6.8
Jackson, Miss.	32.3	28.4[3]	6.5
Shreveport, La.	33.4	26.9[3]	10.8
Austin, Tex.	32.2	26.4[3]	9.7
Lubbock, Tex.	28.7	14.5	23.6
Hatch, N. Mex.	30.0	3.8	43.6
Mesa, Ariz.	35.3	2.6	54.5
Bakersfield, Calif.	32.1	0.0	53.5

[1] Based on Blaney-Criddle formula with "K" = 0.72.

[2] 60-percent application efficiency is assumed. In certain areas, a considerable amount of the water required may be supplied by underground sources. The values presented are based on average rainfall and temperature, and thus do not reflect seasonal climatic variations or variations due to unfavorable rainfall distribution.

[3] In additinn to rainfall during the growing season at these places, it is assumed that 6 inches of precipitation are stored in the soil prior to planting. It is also assumed that all rains are so distributed and at such an intensity that all precipitation is stored in the root zone. This will seldom be true, and the figure should be adjusted accordingly, because rainfall contributes materially to water used by crop.

are of comparable magnitude for all locations. The variation in irrigation water requirements is due largely to rainfall differences.

TIME AND FREQUENCY OF COTTON IRRIGATIONS

Preplanting Irrigation

Hundreds of cotton fields in Arizona were checked for moisture penetration during a 10-year period (1934 to 1944). From these studies it was observed that on deep, well drained soils water penetration to the potential depth of the root zone is an important factor in production of high cotton yields. Although plant roots do not reach their greatest depth until after several months' growth, subsoil water added at or before planting time will be available when needed by the plants later in the season.

The amount of water required for a preplanting irrigation depends upon soil depth, water-holding capacity of the soil, and the amount of stored water remaining from the previous season or from spring and winter precipitation. Enough water should be applied to wet the soil to the full depth of the root zone. Unless leaching is required for removal of excess salts, there is no advantage in adding more water than is required to wet the soil to this depth. Preplanting irrigation applications on soils with relatively low intake rates should be accomplished with one irrigation for best results.

In numerous instances, a considerable amount of the water applied at the preplanting irrigation is lost by evaporation, deep percolation, or both. Evaporation losses may be decreased in many cases by applying the preplanting irrigation near the planting date. Deep percolation losses can be reduced by applying the correct amount of water required to replenish the root zone reservoirs.

The question is often raised of whether to plant in dry soil and then irrigate, or to plant directly in a moist seedbed. There are two objections to the former method. The first objection is that it is often difficult to get water penetration adequate to support the plant; the second, that certain soils form a crust after an irrigation that may prevent plant emergence. If the soil and irrigation layout are such that deep moisture penetration can be obtained and the soil is not subject to crusting, planting in dry soil and then irrigating is an acceptable practice.

Early-Season Irrigation

It is desirable to obtain the most rapid growth possible from the time seedlings emerge until the first bolls appear. Generally, large plants at this stage of development produce high yields of cotton. Factors that cause rapid early growth are:

- A moist, well prepared seedbed.
- Early planting.
- Adequate fertilization.
- Irrigation early in the day before soil stresses occur and before soil temperatures reach too high a maximum (90° F. at 6 inches). Do not irrigate when soils are too cool (about 70° F. at 6 inches).

A favorable environment, principally of moisture, air, and soil temperature, encourages root penetration and top growth. Withholding the first irrigation until plant stress occurs does not encourage maximum early-season growth.

It was noted in Arizona, as early as 1935, that an irrigation given about the 20th of May stimulated growth of young cotton plants. Subsequent observations have shown the growth is usually stimulated by an irrigation about this date even though one-half of the available soil moisture remains in the 6- to 18-inch zone. It has been observed, also, that irrigation in Arizona may reduce the soil temperature at the 6-inch depth as much as 17° F. and that the cooling effect usually persists for about 6 or 7 days. Figure 10 shows the effect of such a cooling irrigation applied on May 26, 1944, at Mesa, Ariz., when the maximum temperature 6 inches below the soil surface was 90°. However, early irrigations were found to retard growth when the soil at the same depth and under similar moisture conditions had temperatures in the upper 70's.

These observations indicate that when soil temperatures are high, early irrigations may help plant growth by reducing soil temperature as well as by reducing soil moisture stress. When soil temperature is low a similar early irrigation may depress plant growth.

In central Arizona, irrigation before the 15th of May usually retards growth of cotton plants and reduces the yield slightly. If irrigation is delayed later than about June 1, growth is also decreased and lower yields are obtained. An irrigation given early in May can be beneficial on the Yuma Mesa in Arizona and in the Imperial Valley of California where early-season temperatures are higher and earlier planting dates are observed. In the cooler areas of the Cotton Belt, such as the El Paso, Tex., area, the earliest date for irrigation probably should not be before the 15th of June.

Midseason Irrigation

Highest cotton yields are usually obtained where conditions for maximum vegetative growth exist until the first bolls appear. This provides plants that have adequate leaf area and a framework or scaffolding large enough to hold a good early set of bolls. Experimental studies indicate that midseason irrigations encourage fruiting and should continue until the later part of the major flowering period. Irrigation frequencies can then be reduced because (1) the root system contacts water at increased depths, and (2) rapid vegetative growth is not desired after this date, for then a greater moisture deficit can be tolerated. In fact, permitting cotton plants to withdraw soil moisture to the extent that they show a slight moisture stress before each irrigation during the midseason may increase rather than decrease yields. The benefit to the plant can be recognized further by the dark blue-green color of the foliage and by the profusion of blossoms above the plant foliage. (See fig. 11.)

If certain climatic conditions or management practices cause delayed blooming, delaying irrigation until the plants show a moderate moisture stress will induce desirable fruiting habits rather than undesirable vegetative growth.

If adequate water penetration is obtained on deep, well-drained soils at the preplanting irrigation, it is usually safe to withhold irrigation after bolls begin to open. At this time, plants have usually withdrawn most of the available water from the upper third of the root zone, and will show a slight moisture stress. The water extracted from the soil at the lower depths will adequately sustain the plants, while the stress imposed will discourage excessive vegetative growth and encourage fruiting.

Late-Season Irrigation

Some water is needed by the cotton plant as long as it is maturing bolls. However, since consumptive use declines as a result of cooler weather and since new growth is limited, the rate at which water is used drops rapidly as the crop matures. Late irrigations induce an improved vegetative appearance but the value of late vegetative

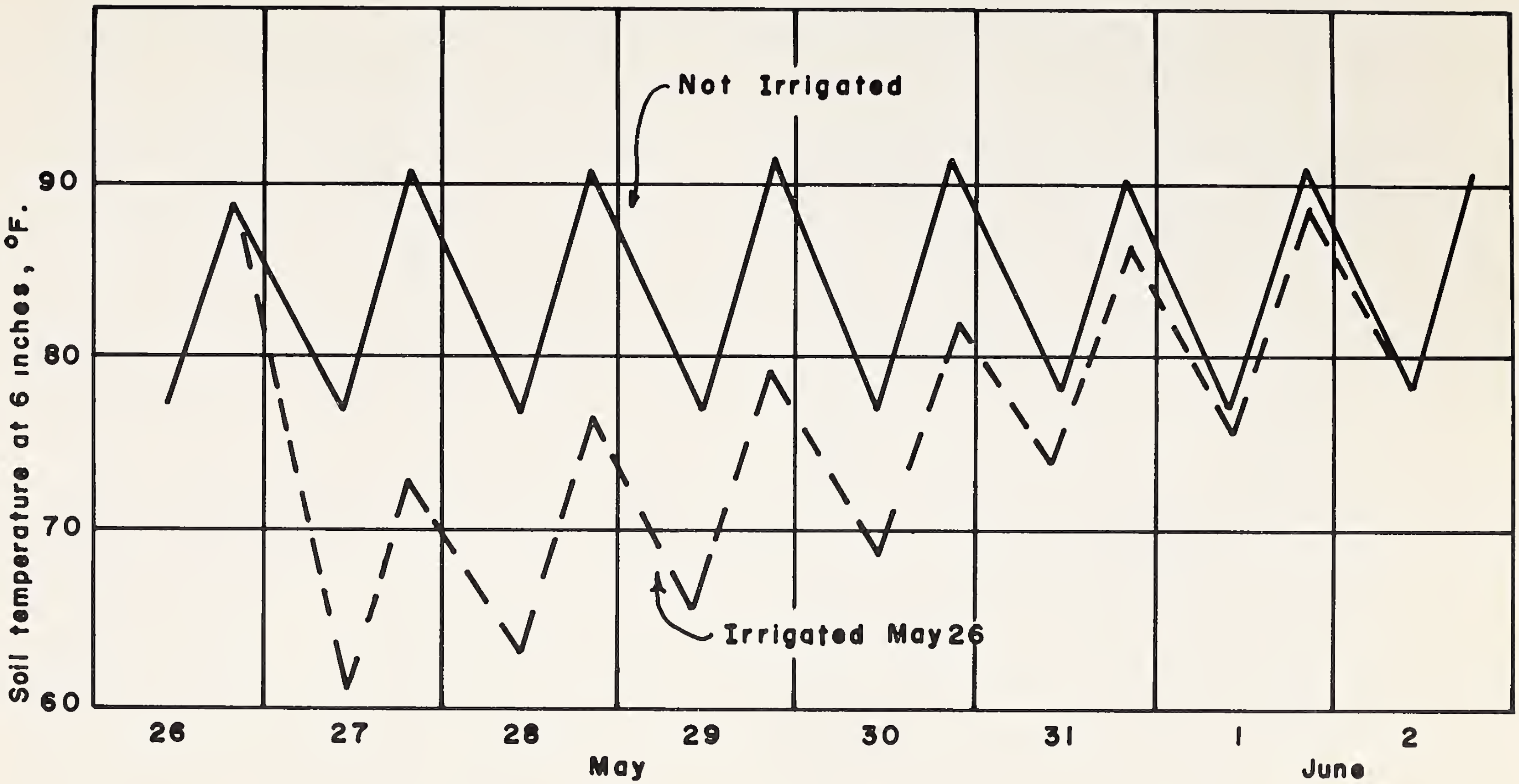


Figure 10. Effect of irrigation on soil temperatures 6 inches below surface. Minimum temperatures about 6:00 a.m.; maximum temperatures about 6:00 p.m., Mesa, Ariz., 1942-45.

Figure 11. Cotton field in Arizona showing profusion of blossoms over the top of the plants. It is a good practice to delay irrigations after mid-August until such flowering occurs.

growth in increasing the yield of lint cotton is questionable. In fact, new vegetative growth near maturity often interferes with mechanical harvesting operations.

Normally, if moisture penetration was secured to a depth of 6 feet on deep, well-drained soils at the beginning of the season, the cotton will have enough water in the 4- to 6-foot zone to supply the plant needs late in the season. If water or plant roots are absent in this zone, it will be necessary to continue irrigating later in the season.

Ten years of cotton-irrigation study at various locations near Phoenix, Ariz., have shown that irrigation after early September is of doubtful value on deep, well-drained soils having good water-holding capacities. On shallow soils or soils with low water-holding capacities, it may be desirable to continue irrigation until the middle of September. However, in the latter case the plants should be allowed to exhaust the moisture at the lower depths before irrigating and should not be kept succulent by frequent applications of water.

SUMMARY

1. Three methods of irrigating cotton are in common use in the Southwest:

(1) Furrow; (2) Level border or basin; and (3) Sprinkler. The furrow method is the most common and is well-adapted to this crop. Level borders or basins are increasing in popularity because of the high application efficiencies obtained by the method and its adaptability to leaching out excess salts. The sprinkler method is generally employed where topographic or soil conditions prevent the use of other methods.

2. Cotton roots may penetrate to depths of 6 feet or more on deep, well-drained soils in the Southwest. On such soils, deep root penetration with adequate fertilization is usually associated with high yields. Shallow water penetration, tillage pans or other dense soil layers, poor soil aeration, adverse soil temperatures, high salt concentrations, and plant root diseases or parasites may limit root penetration and thus reduce yields.

3. Good water penetration at the preplanting irrigation for deep soil moisture storage and/or for leaching of salts is best obtained by applying the water immediately after plowing thoroughly dry soil. This procedure, known as "rough tillage", also facilitates seedbed preparation and increases intake rates of postplanting and subsequent irrigations.

4. Cotton plants use between 25 and 45 inches of water annually depending upon prevailing agronomic and climatic conditions. About 70 percent of this water is used from the upper one-half of the root zone.

5. In areas of low rainfall, most of the water used by the cotton plant must be supplied by irrigation; however, where appreciable rainfall occurs during the growing season, the irrigation schedule should be adjusted according to the intensity and distribution of precipitation. Delaying irrigation in anticipation of rainfall may result in moisture stresses that severely reduce yields.

6. In arid areas, adequate preplanting irrigation is desirable. If deep water penetration is secured at this time, subsequent irrigations need not wet the soil profile deeper than 2 to 4 feet.

7. An early irrigation when soil temperatures reach about 90° F. at the 6-inch depth may be desirable to lower soil temperature as well as to supply moisture. Such irrigation should be avoided if soil temperatures are below 70° at the 6-inch depth.

8. Any procedure that encourages rapid growth of cotton plants during the early part of the season usually increases yield. Irrigations early in the season, but only after the soil is warmed up, usually increase early vegetative growth.

9. Excessive vegetative growth should not be encouraged after the first bolls have opened. Vegetative growth can be retarded and fruiting may be encouraged by withholding irrigation until the plants show a slight moisture stress.

10. Even though the consumptive use rate is reduced in late summer and fall, cotton needs some water to mature the bolls. If deep water penetration exists on deep, well-drained soils at planting time, cotton plants will usually obtain sufficient moisture from the lower depths to supply the plant needs late in the season. If deep penetration was not obtained or if the soil or root system is shallow, irrigation should be continued later in the season. However, plants should not be kept succulent by frequent watering.